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(54) **DEVICE FOR BIOLOGICAL CLEANING AND FILTRATION OF AIR.**

(57) The device comprises, consecutively mounted along the flow passage, a rough cleaning filter (1), an ionizer (5), an additional disk (9), a fine cleaning filter (10) and a power source (23). The rough cleaning filter (1) is an electric filter consisting of three adjacent plates (2, 3, 4) the two extremes (2, 3) of which are made of a cellular metal and are electrically connected to the opposite poles of the power source (23), whereas the central plate (4) is made of polyurethane. The rough cleaning filter (1) is in direct contact with the cylindrical non-corona-forming electrode (6) of an ionizer (5).

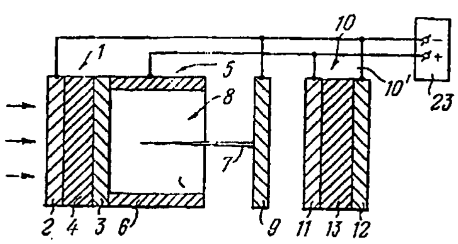

FIG.1

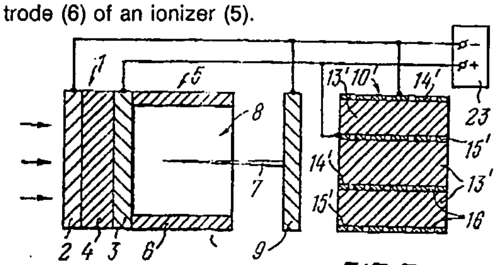

FIG.2

EP 0 600 101 A1

Field of the Invention

The present invention relates to air cleaning plants and more particularly to apparatus for biological cleaning and filtration of air.

State of the Prior Art

An apparatus for biological cleaning of air is known from US Patent A 3,918,939, said apparatus comprising a housing, at least one nondischarging precipitation electrode and at least one discharge electrode.

In the above apparatus, the particles suspended in air are forced to enter the working zone where they are exposed to electric forces influencing on the magnitude and polarity sign of their charge. Depending on the magnitude of this charge and its sign, the particles are precipitated on the electrodes and collecting plates so that cleaning of air is ensured thereby.

In that apparatus, a variation in the charge of the particles under the influence of the electric field and their precipitation take place simultaneously. Therewith, some of the particles because of insufficient time they stay in the electric field fail to receive the charge required for precipitation and pass to the outlet from the apparatus. The efficiency of filtration here depends on the strength of the electric field, the air flow rate and properties of the particles. Thus, the efficiency is proportional to the consumption of energy and, as a rule, is low.

A similar apparatus for cleaning and filtration of air is known from US patent A 1,346,207, said apparatus comprising cartridges with filter elements of basaltic cardboard with water-repellen impregnation that are arranged across the flow in parallel to each other

In the above apparatus, air containing the particles to be removed is forced through plates. Therewith, those particles are retain mechanically which have their geometrical dimensions to exceed the dimensions of cardboard pores.

In addition to this, the water-repellent impregnation of cardboard gives rise to the formation of electrostatic charge of the particles to cause their precipitation on the walls of the pores. However, such an apparatus is also not sufficiently efficient since the cardboard used has low permeability and small size of pores, and this increases substantially its aerodynamic drag. As a result, this apparatus has a short service life since the pores get rapidly clogged with the particles thus retained, and the water-repellent impregnation looses its tribostatic properties with time. Besides, a substantial positive pressure is required to be built up in the system to ensure the operation of such an apparatus.

An apparatus for biological cleaning and filtration of air is also known from Japanese Application No. 55-28736, said apparatus comprising a coarse filter, an ionizator formed by at least a pair of electrodes connected to the unlike terminals of a power source, and a fine filter, which are installed in this succession along the path of the gas flow. The coarse filter is made of woven filtering material.

The ionizator includes unlikely charged electrodes.

The fine filter comprises successive layers of woven filtering material and a reservoir filled with liquid.

Air to be cleaned is fed forcibly to the apparatus and passes through the coarse filter where the particles are retained which have the size thereof to exceed the size of the cells in the woven material. The particles remaining in the air then enter the ionization zone of the ionizator together with the air flow, where they acquire an electric charge and are precipitated on the electrodes. Some of the particles that still remain in the air will deposit on the wooven fine filter and on the surface of liquid.

In that apparatus, a combined mechanism of collecting the particles is realized: due to mechanical capture and electric forces, as well as molecular forces.

Since the efficiency of cleaning is determined by the quantity of particles thus removed, it is rather important to do so that each of the components of the cleaning apparatus would retain as many particles as possible. However, in this design the quantity of particles retained on the plate of the coarse filter will, like also in the apparatus described herein above, depend on the size of the cells in filtering material, i.e., the smaller the size of the cells, the higher will be the efficiency of filtration (smaller particles removed), but simultaneously there is an increase in aerodynamic drag, and this leads to a reduction in efficiency and shorter service life since the filtering material becomes dirty more rapidly and higher air pressure is required to overcome the drag of the filter ~ a factor which involves additional consumption of energy.

All the designs described herein above show low efficiency of biological cleaning of air and shorter service life; besides, their characteristics are unstable and depend on "fouling" of filtering materials. It should be also pointed out that the ionizators of electrostatic precipitators release large quantities of ozone and nitrogen oxides, and this makes it difficult to use them in human environment.

Summary of the Invention

The basis of this invention is formed by the object to provide an apparatus for cleaning and filtration of air, wherein the coarse filter has a design allowing to retain most of the particles to be removed, without an increase in aerodynamic drag of the filtering plates, so that as many microorganisms are killed therewith as possible, and characterized by low quantity of ozone leaving the plant. This is accomplished owing to the fact that in an apparatus for biological cleaning of gas, said apparatus comprising a coarse filter, an ionizator formed by at lease a pair of electrodes connected to the unlike terminals of a power source and a fine filter, which are installed in this succession along the path of the gas flow, according to the invention, use is made of a course electrostatic precipitator consisting of at least three plates arranged across the gas flow adjacently to each other, the outermost ones of which are made of gas-permeable current-conducting material and connected to the unlike terminals of a power source, whereas the central plate located therebetween is made of high-porous electret material. Therewith, as such gas-permeable current-conducting material it is reasonable to use cellular metal having open porosity of at least 85% and pore diameter of 0.3 : 5 mm, and as such high-porous electret material it is reasonable to use polyurethane foam having open porosity of at least 85% and pore diameter of 0.3 : 5 mm.

It is desirable that the size of pores in the filter elements be selected 0.3 : 5 mm since a reduction of the size below 0.3 mm leads to a considerable rise in aerodynamic drag, whereas an increase thereof above 5 mm reduces the influence of electric forces on the particles, an this in turn impairs efficiency of their removal.

In case when the ionizator comprises a discharge electrode shaped as a needle arranged along the gas flow, and a nondischarging electrode shaped essentially as a hollow cylinder arranged coaxially relative to the needle, it is desirable that the cylindrical electrode has the end face thereof to about on the nearest current-conducting plate so that it overlaps it completely.

The fine filter is reasonable to be made similarly to the coarse filter. Therewith, the plates of the fine filter can be made of metal and arranged to be disposed either across the gas flow or in the parallel thereto. In this case, in order to ensure a minimum weight and improve the conditions for draining the charge off, it is preferable to make the current-conducting plates of the fine filter perforated.

Based on conditions of packaging, for instance, with the housing made as a cylinder, the plates of the fine filter can also be made as cylinders arranged to be disposed coaxially.

In the apparatus for cleaning and filtration of air it is reasonable to install an additional ionizator which has the design thereof similar to that of the main one. Therewith, the pairs of electrodes of the main and additional ionizators should be connected to the power source so that the nondischarging electrode of the first ionizator and the needle of the second ionizator are connected to the same terminal of the power source, and the needle of the first ionizator and the nondischarging electrode of the second ionizator to the terminal of the power source having the opposite sign.

It is also desirable to use cylinders having different internal diameters as nondischarging electrodes in the main and additional ionizators.

It is preferable to form a ionizator from a plurality of, e.g., hexahedral prisms arranged compactly and oriented along the direction of gas flow, said prisms having their side faces to abut with each other, thus forming a honeycombed structure. Therewith, the discharge electrodes made as needles are arranged along the axial line of the prisms, whereas the current-conducting plate abutting with the ionizator is made to have such a size that it overlaps the entire end surface of the honeycombed structure.

Brief Description of the Drawings

Hereinafter the invention will be described by way of examples in more detail with reference to the accompanying drawings illustrating specific embodiments thereof, in which according to the present invention:

Fig. 1 shows schematically a general view of the apparatus for biological cleaning and filtration of air in its longitudinal section;

Fig. 2 is an embodiment of this apparatus with parallel plates of the fine filter in its longitudinal section;

Fig. 3 is the fine filter with plates shaped as coaxial cylinders, end view, in its longitudinal section;

Fig. 4 is an embodiment of this apparatus with an additional ionizator, in its lateral section;

Fig. 5 is an embodiment of this apparatus in which the cylindrical electrodes of the ionizator are made to have different internal diameters, in its longitudinal section;

Fig. 6 shows schematically an ionizator having a plurality of electrode pairs, in its longitudinal section; and

Fig. 7 is a section through UP-UP in Fig. 6.

Best Mode for Carrying out the Invention

With reference to Fig. 1, the apparatus for biological cleaning and filtration of air, according to the invention, comprises a coarse filter 1 formed by two plates 2 and 3 made of gas-permeable current-conducting material, preferably cellular metal. This material is characterized by good electric conductivity, high porosity, stable structure. Inserted between these plates 2 and 3 is a plate 4 of dielectric, preferably made of high-porous electret material such as, for instance polyurethane foam. This material is characterized by high porosity (up to 98%), stable structure, good electric and tribostatic properties.

With this, it is desirable to have the size of pores selected on the basis of meeting the requirements of maximum permeability and sufficiency of electrostatic forces for precipitation of charged particles.

The current-conducting plates 2 and 3 are connected electrically to the unlike terminals of a power source.

Located downstream the last plate 3 in the path of gas flow is an ionizator 5 formed by a non-discharging electrode 6 and a discharge electrode 7. With this, the nondischarging electrode 6 is made as a cylinder 6 forming an ionization chamber 8, whereas the discharge electrode is made as a needle 7 arranged to be disposed along the axis of the above-mentioned cylinder 6. The end face of the cylindrical nondischarging electrode 6 abuts on the current-conducting plate 3 of the coarse filter 1 and is in an electrical contact with it.

Mounted at the base of the needle 7 is an additional plate 9 made of current-conducting high-porous material, like also the plates 2 and 3. With this, the plate 9 is in an electrical contact with the needle 7 and connected to the terminal of the power source, which has the sign opposite to that of the plate 3.

The additional plate 9 is designed for additional filtration and electrostatic precipitation of the charged particles, as well as for restricting the ionization zone and reducing the quantity of ozone released.

Located downstream the additional plate 9 is a fine filter 10 which has its design similar to that of the coarse filter 1. The current-conducting plates 11 of the fine filter 10 are also made of cellular metal having porosity of at lease 86%, whereas the dielectric plate arranged to be disposed between them is made of polyurethane foam. With this, the first current-conducting plate 11 in the path of gas flow, which is the nearest one to the additional plate 9, is connected to the terminal of the power source, which has the sign opposite to that of the plate 9, whereas the second current-conducting plate 12 is connected to the terminal of the power source, which has the same sign with that of the plate 9. Such connection of the current-conducting plates 11 and 12 of the fine filter 10 ensures higher probability of precipitation of the charge particles on the plates.

The embodiment of the apparatus shown in Fig. 2, in contrast to the apparatus shown in Fig. 1, comprises a fine filter 10' with plates 13', 14' and 15' arranged to be disposed along the path of gas flow. With this, the current-conducting plates 14' and 15' are made of sheet metal having perforations 16, whereas the dielectric plates 13' are made of polyurethane foam. The current-conducting plates 14' and 15' are alternately connected to the unlike terminals of the power source. The perforations 16 of the plates 14' and 15' are desirable for better conditions of draining the charge off and for reducing the weight of the current-conducting plates.

The fine filter 10" shown in Fig. 3 differs from the filter 10' shown in Fig. 2 by that plates 13", 14" and 15" are made as cylinders arranged to be disposed coaxially relative to each other, the cylinder coincident with the axis having therewith a zero diameter, i.e., it is essentially a stem. Such an embodiment increases the filtering surface without an increase in the overall dimensions of the filter, improves the capacity of the filter as well as ensures convenient packaging.

The embodiment of the apparatus shown in Fig. 4, in contrast to the embodiment shown in Fig. 1, comprises an additional ionization 17 arranged to be disposed in parallel with the main ionizator. With this, the additional ionizator 17 is located so that its cylindrical electrode has the end face thereof to abut on the plate 9 and, respectively, it has the charge of the same sign as also the plate 9. With this, a needle 19 and a plate 20 are connected to the terminal of the power source having the opposite sign as compared with that of the charge of the cylindrical electrode 18. In this case, the air which flows through the apparatus and had to be cleaned, passes successively the ionization chambers having the corona discharges opposite to each other by their sign, and this causes recharging of the particles to be removed so that the probability of killing the microorganisms and viruses that are on them or suspended in the air is increased thereby and, hence, the efficiency of cleaning is thus improved.

Fig. 5 in contrast to Fig. 4 shows schematically an embodiment of the cylindrical electrodes 18 and 21 which are inside the ionizators 17 and 22 arranged in series with one another and have different internal diameters. In this particular case, the internal diameter of the cylindrical electrode 21 of the ionizator 22 which is the first one in the path of

the flow, is smaller than the internal diameter of the cylindrical electrode 18 of the second ionizator 17. Such an embodiment ensures optimization of the conditions for charging and recharging the particles, thus improving the efficiency of cleaning.

With this, discharge electrodes of the main ionizator 17 and additional ionizator 22 are connected to the unlike terminals of the power source 23.

Figs. 6 and 7 show schematically an embodiment of an ionizator having a plurality of electrode pairs 24 forming thereby a plurality of ionization chambers. With this, the most compact structure is obtained when nondischarging electrodes 25 are shaped as hexahedral prisms, whereas the discharge electrodes are made as needles 26, and this also improves substantially the adaptability of the apparatus to streamlined manufacture. The current-conducting plate 3' of the coarse filter, which is the nearest one to the ionizators, is made to have such a size that it overlaps all the internal cavities of the prism-like electrodes 25 of the ionizator.

The apparatus illustrated in Fig. 1 operates in the following manner.

When the power source 23 is switched on, all the components connected to its terminals acquire an electric charge. These components include the plates 2 and 3 of the coarse filter and the plates 11 and 12 of the fine filter as well as the additional plates 9 and electrodes 6 of the ionizator. With this, every next component, or, if the components are connected with each other, the combination of components is connected to the unlike terminals of the power source so that an electric field, therefore, appears between plates 2 and 3 and plates 11 and 12 of the filters, which depolarizes the plates 4 made of dielectric, whereas a corona discharge appears between the electrodes 6 and 7 of the ionizator. The air to be cleaned passes through the current-conducting plates 2 and 3 and dielectric plates 4 of the coarse filter where the largest particles are retained due to mechanical capture and forces of electrical attraction.

With this, owing to the fact that porous cellular material or foam is used for the filtering plates in contrast to the known woven structures (nets) which have their mechanism of retaining determined by the capability of the particles to pass through the cells or not, more efficient retaining is ensured since it is determined not only by the size of the cell, in this case, by the size of the pore, but also by the thickness of the filter element. The configuration of a pore passage which is, as a rule, curvilinear, does not allow the particles to fly freely therethrough without coming into contact with its surface. And such a contact will lead either to retardation or to final retaining of the particles. Therewith not only those particles which have the size thereof to exceed that of the pores will be retained like it takes place in woven structures, but also the particles of smaller size because of their catching or hitting thereof into irregularities of the pore passage. The particles possessing an initial charge will stay for a longer time under the influence of the charged plates 2 and 3 of the coarse filter 1 due to the mechanism of retardation described above so that the probability, hence, increases that they will precipitate under the effect of electric forces.

The particles that have passed through the coarse filter 1 and, together with them, the microorganisms and viruses enter the ionizator 5. With the plates 3 of the coarse filter 1 arranged to be disposed immediately adjacent to the end face of the cylindrical electrode 6 of the ionizator 5, the most optimum distribution of the electric field is ensured inside the ionization chamber 8 so that the particles, microorganisms and viruses leaving the coarse filter find themselves straight away under its influence, and this also restricts their movement forward and, hence, increases the time they are under the effect of electric forces. The particles acquire a large charge, whereas the microorganisms and viruses are subjected to inactivation.

Depending on the charge acquired, the particles with inactivated microorganisms and viruses are partially precipitated on the surfaces of the electrodes 6 and 7. As it is known, the corona discharge is accompanied by releasing ozone which in large quantities has an unfavourable effect on people. Since the plate 3 abuts tightly on the ionization chamber 8, this creates, on the one hand, a purely mechanical obstacle to the egress of ozone and, on the other hand, the ozone in contact with the plate decomposes owing to the charge existing on the plate. In addition to this, the most optimum distribution of the electric field of the corona discharge inside the chamber 8 as already mentioned above, by itself reduces the quantity of ozone thus released.

Downstream the ionizator, the air flows through the additional plate 9 which is connected with the needle 7 of the ionizator and which, since it is made of cellular metal, retains appropriately some of the particles, microorganisms and viruses mechanically in its pores, whereas some of the particles, microorganisms and viruses more are precipitated on it due to electric forces. In addition to this, the additional plate 9 restricts the ionization chamber 8 to some extent on the exit side, thus improving the charging conditions and reducing the quantity of ozone released therefrom. As a result, the total content of ozone in the air flow leaving the apparatus of the present invention does not exceed the values adopted for the ultimate allowable con-

centrations.

Further, the air with the partilces, microorganisms and viruses still left suspended therein enter the fine filter 10 where, like in the coarse filter, mechanical and electrostatic precipitation of the particles, microorganisms and viruses also takes place. The air thus cleaned and made harmless by removal of microorganisms and viruses therefrom flows from the fine filter 10 to the outlet from the apparatus.

The apparatus shown in Figs. 2 and 3 differs from the apparatus shown in Fig. 1 only by an alternative embodiment of the fine filter 10 or 10". The air is cleaned therein and the microorganisms and viruses inactivated just in the same manner like also in the apparatus shown in Fig. 1.

The operation of the apparatus shown in Fig. 4 goes on just in the same manner like also in the apparatus shown in Fig. 1, but the air to be cleaned passes additionally through another ionizator 17 installed in series with the main ionizator 5. The electrodes 18 and 19 of that ionizator 17 are connected to the power source 23 in such a manner that the corona discharge produced therein is opposite by its sign to the corona discharge in the main ionizator 5. Owing to this, the air thus being cleaned is additionally subjected to the influence of the charge opposite by its signs, and this is favourable for additional precipitation of the particles on the electrodes 18 and 19, whereas the recharging of microorganisms and viruses makes their inactivation more probable, i.e., they are killed in larger quantities under the influence of the field having the opposite sign.

The apparatus shown in Fig. 5 operates just in the same manner like the apparatus shown in Fig. 4 but, owing to the fact that the cylindrical electrodes 21 and 18 having different internal diameters are used in the main ionizator 22 and in the additional ionizator 17, respectively, the possibility is ensured for creating an electric field that is the most optimum one for retaining the particles depending on their size. This is attributed to the fact that in order to retain larger particles it is required to have a higher magnitude of electric charge which, in particular depends on the strength of the electric field determined in its turn by the distance between the discharge and nondischarging electrodes: the smaller this distance, the higher is the strength of the electric field.

For just the same reason, as well as to ensure safe operation from the viewpoint of the maximum strength of electric field possible in the ionization chambers, use is to be made of an ionizator packaged as shown in Fig. 6 to comprise a plurality of electrode pairs 24. In the apparatus shown in Fig. 6, the air to be cleaned flows into a plurality of ionization chambers formed by the electrode pairs 24 where the precipitation of particles and the inactivation of microorganisms and viruses take place. Further the air being cleaned passes through the components of the apparatus according to the present invention just in the same manner like in the embodiment shown in Fig. 1.

Thus, an apparatus made in accordance with the invention, thanks to the use of a coarse electrostatic precipitator made on the basis of cellular metal and polyurethane foam, as well as arranging it to be disposed adjacently to an ionizator have allowed to eliminate the shortcomings existing in the known cleaning apparatus: there is no substantial increase in the aerodynamic drag of the filtering plates, with the air passed at a higher rate therethrough so that their service life does not become, therefore, shorter, there is an increase in the quantities of the particles retained and the viruses killed, and the quantity of ozone released is reduced to the minimum.

In accordance with Fig. 1, a mock-up of the apparatus has been made, and its tests have been carried out with ambient air cleaned therein, as a result of which we have obtained the following data:

- sterilization efficiency is 100%;
- filtration efficiency for the particles having the size within 0.01 to 10 microns is 99%; and
- capacity is 135 m^3/hour.

The apparatus is simple in operation, has small dimensions and is superior to the known apparatus by its characteristics.

Industrial Usability

The apparatus can be used in medicine for biological cleaning of air in operating, pus-biological and other rooms; in pharmacology and microbiology; at locations where stringent requirements are imposed on purity and sterility of air, as well as in electronic industry and other industries where the quality of products manufactured is dependent upon the purity of air.

Claims

1. An apparatus for biological cleaning and filtration of air, said apparatus comprising a power source (23) as well as a coarse filter (1), an ionizator (5) formed by at least a pair of electrodes (6, 7) connected to the unlike terminals of the power source (23) and a fine filter (10), which are installed in this succession along the path of the gas flow, characterized in that used as said coarse filter (1) is an electrostatic precipitator consisting of at least three plates (3, 2, 4) arranged to be disposed across the path of the gas flow adjacently to each other, the outermost (2, 3) ones of which are made of

gas-permeable and current-conducting material and are connected electrically to the unlike terminals of the power source, whereas the central plate (4) located therebetween is made of high-porous electret material.

2. The apparatus according to claim 1, wherein said ionizator (5) comprises a discharge electrode shaped as a needle (7) arranged to be disposed along the path of the gas flow, and a non-discharging electrode shaped essentially as a hollow cylinder (6) arranged to be disposed coaxially relative to the needle, characterized in that:
   - the current-conducting plate (3) which is the nearest one to the ionizator abuts on the end face of the cylindrical electrode (6) so that it overlaps it completely.

3. The apparatus according to claim 1, characterized in that:
   - used as said gas-permeable and current-conducting material for filtering is cellular metal having open porosity of at least 85% and pore diameter of 0.3 to 5 mm.

4. The apparatus according to claim 1 or 2, characterized in that:
   - used as said high-porous electret material is polyurethane foam having open porosity of at least 85% and pore diameter of 0.3 to 5 mm.

5. The apparatus according to any one of claims 1, 2, or 3, characterized in that said fine filter (10) has a design similar to the design of the coarse filter (1).

6. The apparatus according to claim 1, characterized in that the plates (13', 14', 15') of the fine filter (10) are arranged to be disposed in parallel with the direction of the gas flow.

7. The apparatus according to claim 6, characterized in that:
   - the current-conducting plates (14', 15') of the fine filter (10) are made to be perforated, with holes (16).

8. The apparatus according to claim 6, characterized in that:
   - the plates (13", 14", 15") of the fine filter (10") are shaped as cylinders arranged to be disposed coaxially.

9. The apparatus according to claim 1, characterized in that:
   - it comprises an additional ionizator (17) arranged to be disposed in series with the main ionizator (5) and similar thereto, the discharge electrodes (7, 19) of them being connected to the unlike terminals of the power source.

10. The apparatus according to claim 8, characterized in that the cylindrical nondischarging electrodes (18, 21) of the main and additional ionizators (17, 5) are made to have different internal diameters.

11. The apparatus according to claim 1, characterized in that the ionizator is formed from a plurality of electrode pairs (24), all the non-discharging electrodes (25) being therewith shaped as hexahedral prisms arranged compactly and oriented along the direction of the gas flow so that they have the side faces thereof to abut with each other, thus forming a honeycombed structure, whereas the discharge electrodes (26) have the shape of needles and are arranged to be disposed along the axial lines of the prisms, and therewith the current-conducting plate (3') of the coarse filter which is the nearest one to the ionizator abuts on the end faces of all the prisms (25) so that it ovelaps them completely.

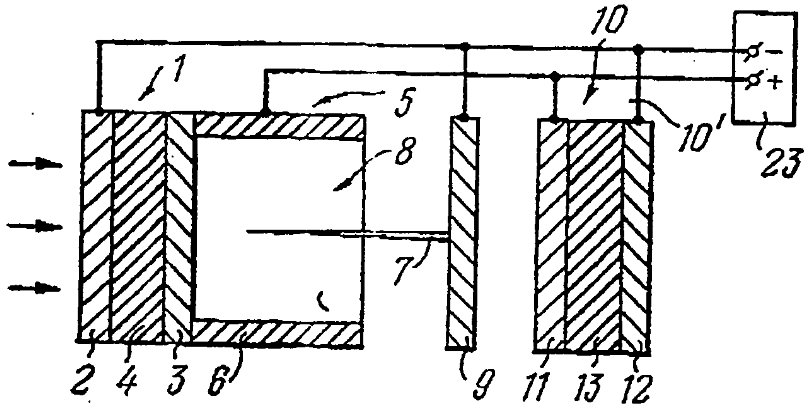

FIG.1

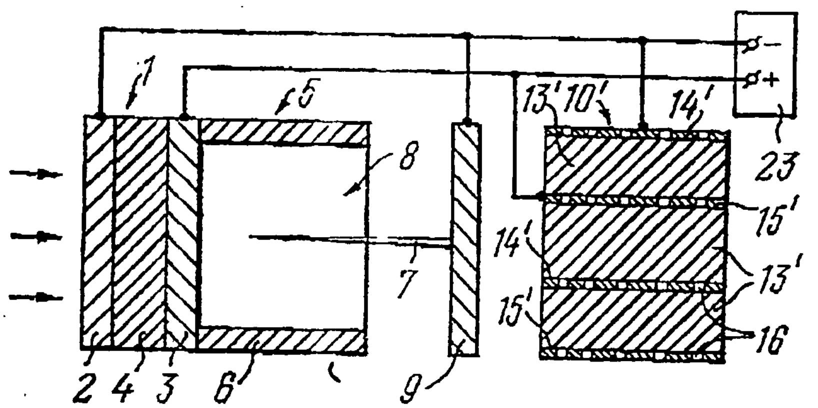

FIG.2

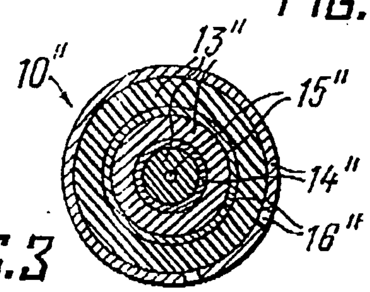

FIG.3

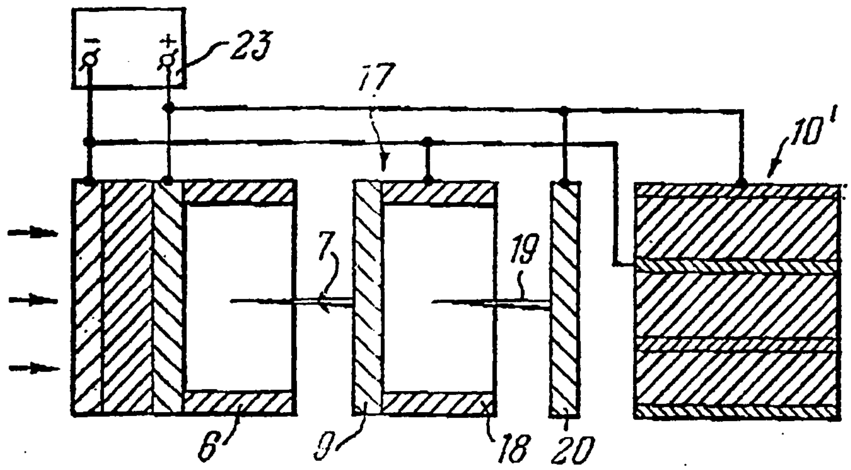

FIG.4

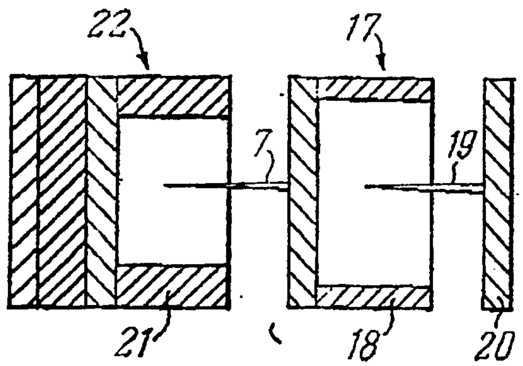

FIG.5

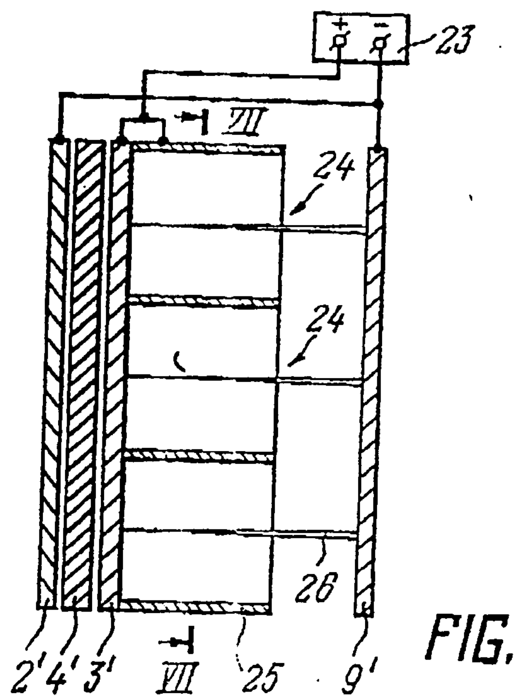

FIG.6

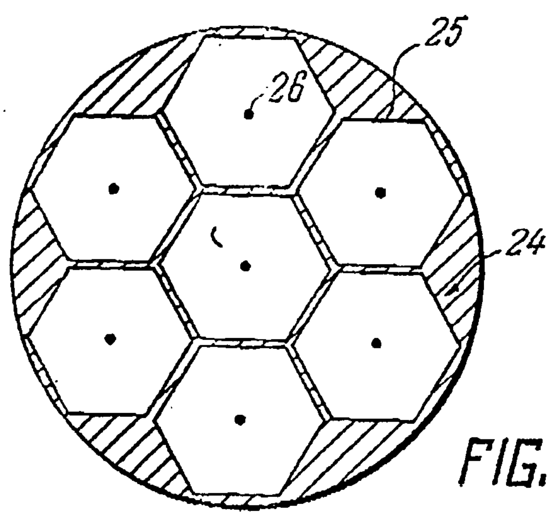

FIG.7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/RU 93/00107

A. CLASSIFICATION OF SUBJECT MATTER

IPC 5 B03C 3/14, A61L 9/22

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC5 B03C 3/00-3/88, A61L 9/22

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	FR, A1, 2220311 (A. W. SCHIRP K.G.) 4 October 1974 (04.10.74) page 3	1,2,5,6,9,11
A	US, A, 3735560 (CARRIER CORPORATION) 29 May 1973 (29.05.73) columns 3-5	1,3,4,6,7
A	US, A, 3798879 (BUDERUS'SCHE EISENWERKE) 26 March 1974 (26.03.74) column 4	1,2,5
A	DE, A1, 2658510 (SACHS SYSTEMTECHNIK GMBH) 29 June 1978 (29.06.78) pages 6,7	1,2,5,6,8,9,11

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
9 August 1993 (09.08.93)	25 August 1993 (25.08.93)
Name and mailing address of the ISA RU Facsimile No.	Authorized officer Telephone No.